Improving Low-Temperature Performance of Lithium-Ion Electrolytes by Duplicating Mutual Repulsions Seen in Saltwater

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Introduction

Lithium-ion batteries suffer from poor performance at low temperatures as a result of decreased molecular activity within the electrolyte. While many electrolytes have been formulated with rapid-charge/discharge or anti-wear properties in mind, no electrolytes have been truly optimized for cold weather performance. A new strategy that involves creating an electrolyte featuring molecules with complementary geometries may aid in both improving cold-weather performance and performance in other key metrics.

Abstract

Borrowing from an oft-misunderstood phenomenon seen in saltwater, one might go about creating a lithium-ion electrolyte with high performance under cold conditions by duplicating the phenomenon that prevents the freezing of saltwater at low temperatures. This approach can be utilized to maintain robust molecular activity at low temperatures without any external source of fluid agitation or heating.

The property of saltwater that helps it to resist freezing is, contrary to popular belief, strong Coulomb repulsions between cubic salt molecules and the V-shaped H2O molecules. When a cubic molecule's edge strays between the "arms" of a water molecule, the water molecule is strongly propelled through the fluid. It therefore stands to reason that an electrolyte consisting of equal parts V-shaped molecules (with longer arms than simple water molecules, ideally) as well as cubic molecules would form a sort of self-sustaining agitation mechanism that would keep the electrolyte's molecular activity comparatively high at unprecedentedly frigid temperatures.

Conclusion

Never before has attention been paid to the comparative geometries of two-compound electrolytes (to the extent that two-compound electrolytes are even being experimented with) and this may be due to the ongoing misconception concerning the behavior of saltwater. With a proper understand of saltwater's resistance to freezing, however, one may create a lithium-ion battery electrolyte of a qualitatively higher order.